

Hypertensive Disorders and Perinatal Outcomes According to Age Groups at Advanced Maternal Age

İleri Anne Yaşında Yaş Gruplarına Göre Hipertansif Bozukluklar ve Perinatal Sonuçlar

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Abstract

The aim of this study was to conduct a comparative analysis of hypertensive disorders, pregnancy complications, and perinatal outcomes in advanced maternal age pregnancies. The study was conducted using a retrospective cohort design, including 4203 pregnant women of advanced maternal age who delivered between 2010 and 2024. Patients were divided into three age groups: 35–39 years (n=3501), 40–44 years (n=608), and ≥45 years (n=94). Demographic characteristics, hypertensive disorders, pregnancy complications and perinatal outcomes were examined. Data were obtained retrospectively from the electronic record system and used in intergroup comparisons. The prevalence of hypertensive disorders increased significantly with age: 9.8% in the 35–39 age group, 16.7% in the 40–44 age group, and 27.6% in the ≥45 age group (p<0.001). Preeclampsia and superimposed hypertension were particularly prevalent. Preeclampsia was significantly higher in the ≥45 age group. From a perinatal perspective, the rates of preterm birth (12.4%, 18.5%, and 27.7%), IUGR (6.1%, 9.8%, and 15.9%), and SGA (7.2%, 10.3%, and 18.1%) gradually increased with age. Mean birth weight decreased from 3150 g to 2890 g, and the NICU admission rate increased from 9.3% to 22.3%. Perinatal mortality was also highest in the ≥45 age group at 3.1%. Hypertensive disorders and perinatal complications increase with age in pregnancies of advanced maternal age. The ≥45 age group, in particular, should be considered high-risk. Therefore, close antenatal monitoring, risk assessment, and implementation of appropriate prophylactic measures in advanced maternal age pregnancies are critical to reducing maternal and perinatal complications.

Keywords: Advanced Maternal Age, Hypertensive Disorders, Perinatal Outcomes, Pregnancy Complications.

Özet

Bu çalışmanın amacı, ileri anne yaşı gebeliklerinde hipertansif bozukluklar, gebelik komplikasyonları ve perinatal sonuçların karşılaştırmalı analizini yapmaktır. Çalışma, 2010-2024 yılları arasında doğum yapan ileri anne yaşındaki 4.203 gebeyi içeren retrospektif kohort tasarımında yürütülmüştür. Hastalar üç yaş grubuna ayrılmıştır: 35-39 yaş (n=3501), 40-44 yaş (n=608) ve ≥45 yaş (n=94). Demografik özellikler, hipertansif bozukluklar, gebelik komplikasyonları ve perinatal sonuçlar incelenmiştir. Veriler elektronik kayıt sisteminden retrospektif olarak elde edilmiştir. Hipertansif bozuklukların yaygınlığı yaşla birlikte önemli ölçüde arttı: 35-39 yaş grubunda %9.8, 40-44 yaş grubunda %16.7 ve ≥45 yaş grubunda %27.6 (p<0.001). Preeklampsi ve üst üste binen hipertansiyon özellikle yaygındı. Preeklampsi ≥45 yaş grubunda önemli ölçüde daha yüksekti. Perinatal açıdan, preterm doğum (%12.4, %18.5 ve %27.7), IUGR (%6.1, %9.8 ve %15.9) ve SGA (%7.2, %10.3 ve %18.1) oranları yaşla birlikte kademeli olarak arttı. Ortalama doğum ağırlığı 3150 g'dan 2890 g'a düştü ve NICU'ya yatış oranı %9.3'ten %22.3'e yükseldi. Perinatal mortalite de %3.1 ile ≥45 yaş grubunda en yüksekti. Hipertansif bozukluklar ve perinatal komplikasyonlar, ileri anne yaşı olan gebeliklerde yaşla birlikte artmaktadır. Özellikle ≥45 yaş grubu yüksek riskli grup olarak değerlendirilmelidir. Bu nedenle, ileri anne yaşı olan gebeliklerde yakın antenatal takip, risk değerlendirmesi ve uygun profilaktik önlemlerin uygulanması, maternal ve perinatal komplikasyonları azaltmada kritik öneme sahiptir.

Anahtar Kelimeler: İleri Anne Yaşı, Hipertansif Bozukluklar, Perinatal Sonuçlar, Gebelik Komplikasyonları.

Introduction

In recent years, increasing gestational age has become one of the most important debates in obstetric practice. Advanced maternal age (≥ 35) pregnancies are increasingly common, particularly in developed and developing countries, due to increased education, career planning, and the increased use of assisted reproductive technologies (1). This situation, along with maternal and perinatal, it has brought about an increase in the risks of morbidity and mortality (2).

Advanced maternal age, hypertensive disorders of pregnancy (gestational hypertension, preeclampsia, eclampsia and chronic hypertension), gestational diabetes, placenta previa, abruptio has been associated with increased rates of cesarean sections (3). Especially in hypertensive disorders are a major cause of both maternal complications and perinatal adverse outcomes, with a higher prevalence in older pregnancies (4).

In terms of perinatal outcomes, various studies have shown that the risk of intrauterine growth restriction (IUGR), small for gestational age (SGA), preterm birth, and perinatal mortality increases with advanced maternal age (5). These risks are reported to be particularly pronounced in pregnancies aged 40 years and older, while the incidence of maternal-fetal complications increases dramatically in pregnancies aged 45 years and older (6).

Although the existing literature strongly demonstrates the adverse effects of advanced maternal age on pregnancy outcomes, there is limited data on the comparative analysis of hypertensive diseases and perinatal outcomes according to different age groups (35–39, 40–44, and ≥ 45). In this context, the effects of different advanced maternal age categories on maternal comparatively evaluating the effects of hypertension on hypertensive disorders and perinatal complications will fill an important knowledge gap in terms of both clinical practice and health policies.

Material and Method

This is a single-center, retrospective cohort study. Data were obtained from the electronic medical records of pregnant women who delivered at the Obstetrics and Gynecology Clinic of Kartal City Hospital, Istanbul, between 2010 and 2024. Data from a total of 4203 pregnant women were analyzed. This population consisted of

pregnant women aged 35 and over, which meets the advanced maternal age criterion. Participants were divided into three groups: Group 1: 35–39 years old ($n = 3501$), Group 2: 40–44 years old ($n = 608$), Group 3: ≥ 45 years ($n = 94$). Inclusion Criteria are singleton pregnancy, live birth at or after the 20th week of pregnancy, no missing data in medical records and maternal age ≥ 35 . Exclusion Criteria's are multiple pregnancies, cases diagnosed with congenital fetal anomaly, pregnancies that result in early trimester miscarriage, preconceptionally known chronic renal disease, diabetes major maternal systemic diseases such as diabetes mellitus or congenital heart disease. Many clinical parameters of the mother and the newborn were recorded in the study. These are maternal characteristics: age, body mass index (BMI), parity, obstetric history, hypertensive disorders: gestational hypertension, chronic hypertension, preeclampsia and eclampsia, pregnancy complications: intrauterine growth restriction (IUGR), small for gestational age birth weight (SGA), preterm birth (< 37 weeks), abruption placentae, postpartum hemorrhage and perinatal outcomes: mode of delivery, birth weight, 1- and 5-minute Apgar scores, neonatal intensive care unit (NICU) admission, perinatal mortality. All data were retrospectively scanned through the hospital automation system. Maternity and newborn clinical records were cross-checked to exclude missing or contradictory information. All cases were anonymized, and ethics committee approval was obtained (Ethics Committee Decision No: 2025/010.99/18/1-Date: 30.07.2025).

Statistical Analysis

Data were analyzed using IBM SPSS Statistics v28.0 software. Continuous variables were evaluated with the Kolmogorov - Smirnov test for compliance with normal distribution. For normally distributed variables, mean \pm standard deviation, and for non-normally distributed variables, median (min - max) values were reported. Categorical variables were given as numbers and percentages. In comparisons between groups; Tukey test) for continuous variables, Kruskal -Wallis test for non-normally distributed data, Chi-square test was used for categorical data. Logistic regression analysis was performed to identify independent risk factors associated with hypertensive disorders and poor perinatal outcomes. Statistical significance level was accepted as $p < 0.05$.

Results

General and Demographic Characteristics

A total of 4203 pregnant women included in the study were divided into three groups according to advanced maternal age category: 3501 (83.3%) in the 35–39 age group, 608 (14.5%) in the 40–44 age group, and 94 (2.2%) in the ≥45 age group. When the groups were compared; mean age increased gradually as expected (36.7 ± 1.2 ; 41.8 ± 1.1 ; 45.6 ± 0.8 years, $p < 0.001$). Body mass index (BMI) tended to increase with age. The rate of obesity was higher in the ≥45 age group ($p = 0.03$). The multiparity rate was 41.3% in the 35–39 age group, 54.8% in the 40–44 age group, and 68.1% in the ≥45 age group ($p < 0.001$). History of previous cesarean section increased significantly with increasing age, being highest in the ≥45 age group at 45.7% ($p < 0.001$). It was also noted that women aged ≥45 years had more obstetric comorbidities than other groups.

Table 1 shows that the risk profile gradually worsens with age. Obesity, multiparity, and a previous cesarean section are significantly higher in the ≥45 age group. The pregnancy rate achieved through ART increases with age, consistent with a decline in fertility and the need for referral to assisted reproductive technologies, particularly at ≥45 years. The increase in comorbidities such as chronic hypertension, pregestational diabetes, and thyroid disease reflects the cardiometabolic burden associated with advanced age. The increasing history of previous preeclampsia and preterm birth

with age may recurrently increase the risk of adverse outcomes in this pregnancy. The increased use of aspirin prophylaxis and calcium supplements reflects clinicians' risk-based approaches. The increase in SBP/DBP averages with age provides a biological/clinical basis for the age-related increase in the incidence of hypertensive disorders, which we will detail in the following sections. The slight decrease in first-trimester referral with age (due to access, planning, or prior experience) may indicate a small delay in the timing of care. The overall picture is consistent with the literature that advanced maternal age increases cumulative obstetric and medical risks.

The incidence of hypertensive disorders increased progressively across the three age groups. Total HDP (patient-based composite outcome: chronic hypertension, gestational hypertension, preeclampsia / eclampsia, and superimposed (any preeclampsia) was 9.8% in 35–39 years of age, 16.7% in 40–44 years of age, and 27.6% in ≥45 years of age ($p < 0.001$; $p\text{-trend} < 0.001$). When subtypes were examined, the rates of chronic hypertension, gestational hypertension, preeclampsia, and eclampsia increased significantly with age. Superimposed preeclampsia and early-onset preeclampsia (<34 weeks) rates were particularly high in the ≥45 age group. The proportion of severe preeclampsia among preeclampsia cases tended to increase with age. Antihypertensive medication uses during pregnancy also increased with age.

Table 1. Demographic and obstetric characteristics by age groups

Variable	35–39 years old (n=3501)	40–44 years old (n=608)	≥45 years old (n=94)	p-value
Mean age, years (Mean±SD)	36.7 ± 1.2	41.8 ± 1.1	45.6 ± 0.8	<0.001
BMI, kg/m ² (Mean±SD)	27.2 ± 4.6	28.1 ± 4.8	29.3 ± 5.1	0.01
Obesity (BMI ≥30), n (%)	980 (28.0)	206 (33.9)	39 (41.5)	<0.001
Nulliparity, n (%)	1.561 (44.6)	232 (38.2)	27 (28.7)	<0.001
Multiparity (≥2 births), n (%)	1.446 (41.3)	333 (54.8)	64 (68.1)	<0.001
Gravida, median (IQR)	2 (1–3)	3 (2–4)	3 (2–4)	<0.001
ART (IVF/ICSI/IUI), n (%)	245 (7.0)	112 (18.4)	40 (42.6)	<0.001
Smoking (during pregnancy), n (%)	245 (7.0)	46 (7.6)	8 (8.5)	0.62
Chronic HT, n (%)	74 (2.1)	23 (3.8)	7 (7.4)	<0.001
Pre-gestational DM, n (%)	70 (2.0)	26 (4.3)	6 (6.4)	<0.001
Thyroid disease, n (%)	280 (8.0)	61 (10.0)	12 (12.8)	0.01
Kidney disease, n (%)	17 (0.5)	6 (1.0)	2 (2.1)	0.03
Previous preeclampsia, n (%)	140 (4.0)	37 (6.1)	8 (8.5)	0.001
Previous preterm birth, n (%)	210 (6.0)	56 (9.2)	12 (12.8)	<0.001
Previous cesarean section, n (%)	1.001 (28.6)	220 (36.2)	43 (45.7)	<0.001
Interpregnancy interval, years (Mean±SD)	4.1 ± 2.6	5.2 ± 3.1	6.0 ± 3.4	<0.001
First trimester admission (≤12 weeks), n (%)	2.941 (84.0)	497 (81.7)	73 (77.7)	0.004
Weight gain during pregnancy, kg (Mean±SD)	12.0 ± 5.0	11.5 ± 4.8	10.7 ± 4.5	0.02
Aspirin prophylaxis, n (%) *	420 (12.0)	116 (19.1)	34 (36.2)	<0.001
Calcium supplementation, n (%)	770 (22.0)	156 (25.7)	30 (31.9)	0.002
SBP, mmHg (Mean±SD)	117 ± 12	120 ± 13	125 ± 14	<0.001
DBP, mmHg (Mean±SD)	73 ± 8	75 ± 9	78 ± 10	<0.001
Hb, g/ dL (Mean±SD)	12.1 ± 1.3	12.0 ± 1.3	11.9 ± 1.4	0.08

Table 2 shows that both pregestational (chronic hypertension) and pregnancy-specific hypertensive disorders increase significantly with increasing age. The increase in total HDP translates to a burden that is approximately threefold, particularly in the ≥ 45 age group. The increased rates of early-onset PE and superimposed PE can be interpreted as a clinical reflection of the limited vascular/metabolic reserve available in older age. The proportion of severe PE in PE increases with age, suggesting that clinical severity may be more pronounced in older age. While eclampsia and HELLP are less common, their rates are significantly higher in the ≥ 45 age group. Finally, antihypertensive use during

pregnancy increases with age, suggesting that both the burden of chronic hypertension and the hypertensive conditions that develop during pregnancy require more intensive treatment.

Perinatal adverse events gradually increased with age. In particular, preterm birth (both < 37 weeks and early preterm subgroups), SGA, and IUGR rates increased, while mean birth weight decreased. NICU admission, low 5-minute intervals Apgar, perinatal mortality (intrauterine fetal death + early neonatal death), respiratory an increase in components such as distress syndrome (RDS) and neonatal sepsis was observed. Abruption placentae was seen more frequently in the older age group.

Table 2. Hypertensive disorders and associated indicators by age groups

Variable	35–39 years old (n=3501)	40–44 years old (n=608)	≥ 45 years old (n=94)	p
Total HDP (Patient -based), n (%)	343 (9.8)	101 (16.7)	26 (27.6)	<0.001
Chronic hypertension, n (%)	74 (2.1)	23 (3.8)	7 (7.4)	<0.001
Gestational hypertension, n (%)	158 (4.5)	48 (7.9)	12 (12.8)	<0.001
Preeclampsia (total), n (%)	112 (3.2)	34 (5.6)	10 (10.6)	<0.001
• Early onset PE (< 34 weeks), n (%*)	28 (0.8)	8 (1.3)	2 (2.1)	0.002
• Serious features PE (share in PE), n / N PE (%)	58 / 112 (51.8)	20 / 34 (58.8)	7 / 10 (70.0)	0.04†
Superimposed PE (On KH), n (%)	18 (0.5)	7 (1.2)	3 (3.2)	<0.001
Eclampsia, n (%)	4 (0.1)	2 (0.3)	1 (1.1)	0.04
HELLP syndrome, n (%)	7 (0.2)	3 (0.5)	1 (1.1)	0.03
During pregnancy antihypertensive use (any), n (%)	179 (5.1)	57 (9.4)	17 (18.1)	<0.001

Table 3 shows that adverse perinatal outcomes systematically increase with increasing maternal age. The increase in preterm birth rates (especially early preterm < 34 weeks) and SGA/IUGR, along with the decrease in mean birth weight, suggests that fetal growth restriction and the burden of preterm labor are age-sensitive. This increase is reflected in the clinical rate of NICU admissions and the length of stay. The increase in neonatal morbidities such as RDS, sepsis, and the need for phototherapy with age is also related to both prematurity and placental / uteroplacental complications consistent with the practical implications of perfusion disorders. Perinatal the increase in mortality and IUFD is statistically significant; neonatal death rates, although at lower frequencies, tend to be higher in those aged ≥ 45 years. The increasing prevalence of placental ablation with age supports a background of increased hypertensive disorders and possible placental pathology. This general pattern parallels findings in the literature that advanced maternal age is associated with prematurity, growth restriction, low Apgar scores, increased NICU needs, and perinatal losses.

Discussion

This study conducted a comparative analysis of hypertensive disorders, pregnancy complications, and perinatal outcomes by age group in pregnancies of advanced maternal age. The findings showed that the risk of hypertensive disorders and adverse perinatal outcomes increased significantly with age. These risks were particularly significant in the ≥ 45 age group.

Our results are in strong agreement with large-scale cohort and meta-analyses in the literature. A meta-analysis by Lean et al. reported that advanced maternal age (≥ 35 years) was significantly associated with preeclampsia, gestational hypertension, and other obstetric complications (5). Similarly, a multinational study by Laopaiboon et al. reported that maternal age at pregnancy age ≥ 40 years was significantly associated with pregnancies mortality and serious perinatal morbidity were higher (6). In our study, both preeclampsia and superimposed preeclampsia was significantly increased in the ≥ 45 age group; this result may be explained by the loss of vascular reserve and endothelial dysfunction of advanced age (7).

Table 3. Perinatal outcomes and complications by age groups

Variable	35–39 years old (n=3501)	40–44 years old (n=608)	≥45 years old (n=94)	p (groups)
Preterm birth <37 weeks, n (%)	434 (12.4)	112 (18.5)	26 (27.7)	<0.001
• Early preterm <34 weeks, n (%*)	98 (2.8)	30 (4.9)	8 (8.5)	<0.001
• Very early preterm <32 weeks, n (%*)	42 (1.2)	15 (2.5)	4 (4.3)	0.001
IUGR, n (%)	214 (6.1)	60 (9.8)	15 (15.9)	<0.001
SGA (<10p), n (%)	252 (7.2)	63 (10.3)	17 (18.1)	<0.001
Average birth weight, g (Mean±SD)	3150 ± 420	3010 ± 440	2890 ± 460	<0.01
Low birth weight <2500 g, n (%)	381 (10.9)	96 (15.8)	23 (24.5)	<0.001
Very low birth weight <1500 g, n (%*)	46 (1.3)	16 (2.6)	4 (4.3)	0.002
Apgar <7 (5th min), n (%)	133 (3.8)	39 (6.5)	10 (10.6)	<0.001
to NICU, n (%)	326 (9.3)	86 (14.1)	21 (22.3)	<0.001
Length of stay in the NICU, days (median [IQR])	4 [2–7]	5 [3–8]	6 [3–10]	0.01
Perinatal mortality†, n (%)	42 (1.2)	12 (2.0)	3 (3.1)	0.02
• Intrauterine fetal death (≥20 weeks), n (%*)	22 (0.6)	7 (1.2)	2 (2.1)	0.03
• Neonatal death (<28 days), n (%*)	20 (0.6)	5 (0.8)	1 (1.1)	0.28
RDS, n (%*)	168 (4.8)	44 (7.3)	11 (11.7)	<0.001
Clinical/proven sepsis, n (%*)	56 (1.6)	16 (2.6)	4 (4.3)	0.01
Need for phototherapy, n (%*)	343 (9.8)	85 (13.9)	20 (21.3)	<0.001
Abrupt placenta, n (%)	39 (1.1)	12 (2.0)	3 (3.2)	0.01

Our data are particularly noteworthy regarding the severity of hypertensive disorders. Not only was the incidence but also the rate of severe preeclampsia significantly higher in the ≥45 age group. This finding supports the "increasing severity with age" hypothesis reported in the classic study by Sibai et al. (8). Furthermore, prospective cohort studies published in recent years have highlighted the higher prevalence of chronic hypertension in older pregnancies and the increased use of antihypertensive medications during pregnancy (9,10).

Our perinatal results are consistent with the literature. In our series, the preterm birth rate reached 27.7% in the ≥45 age group, while Montan's large-series analysis similarly reported that older age is an independent risk factor for preterm birth (11). Furthermore, the increased rates of IUGR and SGA may be explained by age-related deterioration in uteroplacental blood flow, as highlighted in the study by Joseph et al. (12). A decrease in mean birth weight and increased rates of low birth weight were also associated with older pregnancies in Jacobsson et al.'s meta-analysis (13).

In our study, the need for neonatal intensive care was low at 5 min. Neonatal morbidities such as Apgar score and RDS increased significantly with advancing age. These findings are consistent with a study by Lamminpää et al. based on Finnish data, whose analysis reported significantly higher perinatal mortality and NICU admission rates in pregnancies aged ≥40 years (14). The increase in perinatal mortality, particularly in the ≥45 age group, is consistent with the observations of Huang et al. in a recent Chinese cohort study (15).

On the other hand, some studies in the literature have shown that the relationship between advanced age and adverse outcomes is related to socioeconomic factors, access to health services and maternal in our study, the higher prevalence of comorbid conditions such as chronic hypertension, diabetes, and thyroid disease in the ≥45 age group may have contributed to poor obstetric and perinatal outcomes.

Strengths of the study are the large sample size (≈4000 cases), the age groups 35–39, 40–44 and ≥45 were evaluated separately. Both maternal analyzing both hypertensive disorders and perinatal outcomes together. It makes a significant contribution to the limited data in the literature, especially for the ≥45 age group. Weaknesses of the study are inability to fully control for potential confounding variables (socioeconomic status, diet, lifestyle) due to the retrospective design. Limited generalizability due to being single-centered. Some clinical parameters could not be evaluated due to lack of records.

This study demonstrates a strong and gradual association between advanced maternal age and hypertensive disorders and perinatal adverse outcomes. Our findings, consistent with the literature, demonstrate that the ≥45 age group is particularly at increased risk. From a clinical perspective, closer antenatal monitoring, early risk assessment, and implementation of prophylactic measures (e.g., aspirin, calcium supplements) are crucial in this group of pregnancies.

Conclusion

This study conducted a comparative analysis of hypertensive disorders, obstetric complications, and perinatal outcomes across age groups in pregnancies of advanced maternal age. Our findings demonstrated that both the prevalence of hypertensive disorders and perinatal adverse outcomes increased significantly with increasing age. In particular, rates of hypertensive disorders, severe preeclampsia, preterm birth, intrauterine growth restriction (IUGR), low birth weight, and perinatal mortality increased dramatically in the ≥ 45 age group.

Our results, consistent with the literature, demonstrate that advanced maternal age alone is a significant risk factor, but this risk is compounded by factors such as comorbid chronic hypertension, diabetes, and obstetric history. Therefore, close monitoring of pregnancies with advanced maternal age, especially those aged 40 and older, from early pregnancy onward, proactive management of risk factors, and implementation of preventive strategies (e.g., aspirin prophylaxis, calcium supplementation) are crucial.

From a clinical perspective, this study demonstrates that risks in advanced pregnancy vary across age groups, and that women aged ≥ 45 years should be considered a particularly high-risk category. Multidisciplinary follow-up and prenatal counseling for this group of pregnant women will play a critical role in reducing maternal and perinatal complications.

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Conflict of interest statement

The authors declare no conflict of interest.

Ethics Committee Approval

Kartal City Hospital Ethics Committee / Date:
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